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ABSTRACT

Two experiments were conducted in order to determine whether children are able to make analogies in learning to read. In the first experiment, 24 children from a primary school were taught three types of word pairs--only one pair of which was analogies--and then tested. Results showed not only that children are aware that consistency of spelling predicts consistency of pronunciation in the way required for an analogy but also that they are able to apply this knowledge selectively when given conflicting information about spelling-sound sequences. In the second experiment, primary school children were given a "clue" word from which analogies could be made, and then asked to read analogous and nonanalogous test words. The subjects were tested under three different conditions with three different types of test words. If children were able to make analogies in reading without any training on the relevant orthographic sequence, they should have been better at reading the target words than the control words. This pattern of results seems to be supported. These results suggest that the ability to make analogies is not a developmental ability but a fundamental strategy in learning to read. (DF)

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CHILDREN'S USE OF ANALOGY IN LEARNING TO READ

Paper to accompany Poster presented at the SRCD conference
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The question of whether children are able to make analogies in learning to read is both an interesting and an important one. The ability to make analogies in reading requires the recognition of orthographically consistent sequences within words, and the realisation that the spelling-sound relationship characteristic of one sequence should also be characteristic of the other. Similarity of spelling implies similarity of sound. So a child who knows a word like 'peak' should be able to carry over the 'eak' says "eak" relationship to read new words like 'beak' and 'weak'.

If children are able to make analogies in reading, there would be no need to learn all new words as discrete visual wholes, as suggested by visual recognition theories of early reading development (e.g. Gough and Hillinger 1980). Similarly, there would be no need to work out new words on a letter-by-letter basis, a procedure which is prone to error and very laborious. Instead, children could simply use words that they know to achieve pronounciations for analogous new words, so that a child who knew a word like 'beak' would be able to decode new words like 'bean' and 'peak'.

Obviously, the use of analogy in reading should allow rapid expansion of a child's reading vocabulary, and enable the child to build upon current reading knowledge in a flexible way. While some work has been done on children's use of analogy in reading (e.g. Marsh et al 1977, 1981), this work relies on the use of nonsense words, and leads the authors to conclude that analogy is a strategy which does not emerge until the period of concrete operations, and "is not used spontaneously to any great extent until much later in development" (Marsh and Desberg 1983).The two experiments reported here suggest that even very young children are able to use an analogy strategy in reading. They also seem to do so spontaneously. This is in direct contrast to the results of Baron 1977, who presented some evidence suggesting that young children can make analogies in reading following training, but not without much prompting and encouragement from the experimenter.

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EXPERIMENT ONE

The question of whether children are actually able to make analogies in reading was addressed in the first experiment. This was done by simply teaching children a pair of words such as 'peak'-'leak' while drawing their attention to the orthographically consistent sequence, and then seeing whether they were able to carry this information across to read new analogous words such as 'beak' and 'weak'. This first experiment was thus simply looking for the existence of the mechanism required for analogy.

Not all orthographic sequences have a consistent pronounciation, of course, so an attempt was made to look at how children deal with the inconsistencies of English orthography within the same experiment. Children were also taught inconsistent pairs of words such as 'peak'-'steak', where the orthographically consistent sequence has an inconsistent pronounciation. Their performance on decoding new words like 'beak' and 'break' was then examined. The aim was to look at how the analogy mechanism copes with ambiguity. Finally, children were also taught pairs of words where both spelling and sound were inconsistent such as 'peak'-'loan'. The idea here was to see whether one example of a spelling-sound relationship was enough for analogies to be made.

METHOD

Subjects

The subjects for the experiment were 24 children from a local Oxfordshire primary school. If anything, these children were slightly delayed in their reading development, as shown below:

N	MEAN AGE	S.D.	MEAN READING AGE	S.D.	BPVS(IQ)	S.D.
24	7;3	5.89	6;9	5.18	92.25	15.58

Design

i) Overall design

The children were tested under three different conditions - Consistent, Inconsistent and Control (to be described) - with three different wordtypes in each condition - A, B and C. A repeated measures design was used in which all the children did all the conditions and got all the words but in different orders. The children were split into three groups matched for chronological age and reading age, each group getting the three conditions in a different order, with different words per condition. So there was full counter-balancing of both words and conditions.

ii) Procedure common to all trials

On each trial the child was first given the test words to read in random order. These consisted of the pair of words to be taught, 2 analogous words (type A), a word with consistent spelling but inconsistent pronounciation (type B), and 2 words which shared neither spelling nor sound patterns with the pair to be taught (type C).

The child was then told "Now we are going to learn a couple of those words you just tried". The experimenter produced the words to be learned typed on a white card one above the other so that the orthographically consistent sequence was easily defined e.g. peak
leak

The child was then taught the pair of words. The experimenter emphasised the consistent sequence by saying "These letters go together and they say 'eak'". When the child had learned the pair of words, all 7 words seen at pretest were presented again in random order, and the child's pronounciation recorded.

Each child was taught two word pairs per session. There were six word sets in all.

iii) The three conditions

The word pairs were taught under three different conditions:

1. Consistent - the pair of words had a consistent orthographic sequence and a consistent pronounciation e.g. PEAK-LEAK. The experimenter emphasised the orthographically consistent sequence by saying "These letters go together and they say "eak".

2. Inconsistent - the pair of words had a consistent orthographic sequence but an inconsistent pronounciation e.g. PEAK-STEAK. The experimenter said "These letters go together and they say "eak"...These letters go together and they say "ake". No further comment on the ambiguity was made.

3. Control - the pair of words had both inconsistent spelling and pronounciation e.g. PEAK-LOAN. The experimenter said "These letters go together and they say "eak"...These letters go together and they say "oan"".

iv) The three wordtypes

Three different wordtypes were given on each trial. These were as follows:

A - A-type words had the same spelling and pronounciation as the taught pair and so could be read by analogy e.g. for the taught pair PEAK-LEAK, these were 'beak' and 'weak'.

B - B-type words shared the same spelling pattern as the taught pair but not the pronounciation e.g. for PEAK-LEAK, this was 'break'. It was not usually possible to come up with more

than one B-type word.

C - C-type words shared neither spelling nor sound patterns with the taught pair e.g. for PEAK-LEAK these were "lion" and "tour". C-type words were chosen to be as closely matched in frequency as possible with the A-type words, and to have the same CVVC pattern.

v) Additional measures of individual differences

Following the experiment, the children were given standardised tests of verbal I.Q., memory ability and coding skill (WISC Coding subtest). These measures were included to see if they determined analogical ability in any way. The measures were -

a) British Picture Vocabulary Scales: a measure of verbal I.Q. (the British version of the PPVT)

b) The WISC digit span subtest as a measure of memory skill.

c) The WISC coding subtest, as this requires the use of a kind of analogy in carrying across the correct symbol to fill in the correct shape.

vi) Rationale

It was expected that if children could use an analogy strategy, their performance on the A-type words only should improve at post-test. In terms of use of the taught sound, it was expected that this should be extended to the A-type and B-type words, but not to the C-type words.

RESULTS

If children are able to make analogies in reading, they should improve their reading of the A-type words at post-test, but not of the B-type or C-type words. This pattern of performance seems to be supported. The mean number of words read correctly by condition and wordtype is given below:

Mean number of words read correctly - maximum = 4

CONDITION	TEST	WORDTYPE A	B	C
Consistent	Pre	1.08	0.92	1.04
	Post	3.38	0.83	1.25
Inconsistent	Pre	0.92	1.17	1.04
	Post	2.21	1.58	1.29
Control	Pre	1.08	1.17	0.92
	Post	2.88	1.50	1.38

As can be seen, the greatest improvement occured for the A-type words in each case, as predicted. However, this improvement occured on all the conditions, even the inconsistent condition, although the magnitude of improvement here was not so great. To see whether these results were significant, a 3(Condition) x 2(Test) x 3(Wordtype) analysis of variance was performed, taking the number of words read correctly as the dependent variable. This showed a significant interaction between Condition, Test and Wordtype ($F= 4.70$, $p<0.0018$).

Post-hoc examination of this interaction using Neumann-Keuls tests showed that it was due to the performance on the A-type words being signficantly better at post-test as compared to pretest ($p<0.01$). This suggests that analogies were being made.

The table of means also suggests that more analogies were made on the Consistent and Control conditions than on the Inconsistent condition, as would be expected. Neumann-Keuls post-hoc comparisons showed that the post-test scores on the A-type words differed significantly for each condition. Significantly more A-type words were read on the Consistent condition than on the Control condition ($p<0.01$), and on the Control condition than the Inconsistent condition ($p<0.01$).

This means that it was easier to make analogies when trained on consistent pairs of words (peak-leak) or when one example only of the sequence-sound relationship was given (peak-loan) than when conflicting information about the sequence-sound relationship was presented (peak-steak). This is only to be expected. What is interesting is that children can still make analogies with great success in the inconsistent condition. It seems that the ambiguity of letter-sound relationships in English orthography does not present such problems for the beginning reader as it does for the reading theorist.

To examine further the success of children in the inconsistent condition, the results were re-analysed in terms of the number of times a word was read by using the taught sequence, even where this led to an incorrect response. For example, a child learning about the 'eak' sequence from the word pair peak-leak could carry this information over to all the wordtypes as follows:

A - beak, weak pronounced as "beak", "weak" (correct)
B - break pronounced as "breek" (incorrect)
C - tour, lion pronounced as "teak", "leak" (incorrect)

These results would be expected if the children were simply generalising what they had learned rather than making analogies. If analogies are being made, the generalisation of the sequence-sound relationship should be limited to the A-type and B-type words. The mean number of times the taught sequence was used in the pretest compared to the post-test by condition and wordtype is given below:

Mean number of times taught sound used (maximum = 4)

CONDITION	TEST	WORDTYPE A	B	C
Consistent	Pre	1.13	0.58	0.00
	Post	3.33	2.50	0.00
Inconsistent	Pre	0.92	0.25	0.00
	Post	2.21	1.00	0.00
Control	Pre	1.17	0.33	0.00
	Post	2.92	1.75	0.00

As the table shows, the taught sound was used extensively to read the A-type and B-type words at post-test, as would be expected if analogies are being made. It was never used for the C-type words, which rules out explanations of the results based on guessing or simple generalisation.

In order to see whether the pattern of results was significant, a 3(Condition) x 2(Test) x 2(Wordtype) analysis of variance was performed comparing the A and B-type words on the three conditions, taking the number of times that the taught sound was used as the dependent variable.

This showed that there was a significant interaction between Condition and Test ($F = 6.54$, $p<0.0034$). Post-hoc tests (Neumann-Keuls) showed that the interaction was due to the post-test scores on the A-type words differing significantly from the pretest scores on the A-type words on every condition, while for the B-type words this was only true of the Consistent and Control conditions. In the Inconsistent condition the taught sound was not used significantly more often on the B-type words at post-test compared to pretest, as would be expected, since in this condition the children were being given alternative pronounciations for the orthographic sequences in the B-type words, pronounciations which gave the correct reading of these words.

This result suggests that not only do children make analogies in reading, they do so in a very intelligent way. Even when given conflicting information about the pronounciation of an orthographic sequence, they are able to handle this in a way which results in different performance on the Inconsistent condition. While they are misled into making inappropriate analogies on the B-type words in all the conditions, they do so less frequently on the Inconsistent condition. Again, this supports the view that the ambiguities of English orthography do not pose such serious problems for young readers as has sometimes been supposed.

Additional measures of individual differences

In order to see whether the ability to make analogies in reading differed significantly with individual differences in memory or verbal I.Q., a number of fixed-order multiple regressions were run taking the number of analogies made as the

dependent variable. No significant relationships were found. This demonstration that analogical ability does not vary with individual intelligence, memory or coding skills suggests that analogy may be a very basic strategy in reading development, characteristic of children at all levels of ability.

DISCUSSION

This first experiment was designed to see whether an analogy mechanism for reading existed in young children, and how successful they would be in using such a mechanism if it existed given the ambiguities inherent in English orthography. It has shown that not only are children aware that consistency of spelling predicts consistency of pronounciation in the way required for analogy, but that they are able to apply this knowledge in a selective way when given conflicting information about spelling-sound sequences.

This experiment relied on training the children on the relevant orthographic sequences. Because of this it could be argued that the children were not strictly making analogies at all, but were using a taught sound for a letter sequence where they felt it to be appropriate - in other words they had learned a sort of 'rule' such as 'eak' says "eak", and then carried this over to other 'eak' words. For a true analogy to be made, no training should occur. Instead, the child should be left to appreciate the similarity in spelling-sound relationships between analogous words for himself. This was the reasoning which prompted the second experiment reported here.

EXPERIMENT TWO

The performance on the Control condition in the first experiment suggested that one example of a spelling-sound relationship was enough for analogies to be made. Here the children were taught pairs of words which were unrelated such as 'peak-loan', and tested with words similar to one of these words in orthography and pronounciation e.g. beak, weak. They turned out to be very good at reading words analogous to only one of the taught words, nearly as good as they were if they were taught consistent word pairs such as 'peak-leak'.

This result suggests that experience of only one example of a spelling-sound sequence is required for analogy to come into operation. The child does not even need to have the consistency of this spelling-sound relationship made obvious in order to extend it to read new words.

To test whether one word presented in isolation was in fact enough for analogies to be made, a second experiment was carried out in which the child was given a 'clue' word from which analogies could be made, and then asked to read analogous and non-analogous test words. The child's performance was compared to a control condition on which no clue word was present.

In addition, the concept of analogy was extended to include

analogies between the orthographic sequences at the beginnings of words. If a powerful analogy mechanism exists, it should be equally useful for making analogies between the beginnings of words as the ends of words. In other words, a child who knows a word like 'beak' should be able to use this to decode words like 'bean' and 'bead' as well as 'peak' and 'weak'. To test this hypothesis, the children were asked to make analogies under two different conditions, Beginning (where the spelling-sound relationship was consistent between the beginnings of words), and End (where the spelling-sound relationship was consistent between the ends of words).

A final extension of the previous study was to include children on the verge of reading as well as those already able to read some words. If analogy is an important strategy in reading irrespective of ability, it should be found in children just beginning to understand the relationship between print and sound as well as those who already have a reading vocabulary. To examine this idea, some children were included who did not yet score on the standardised test of reading being used (the Schonell). Children who do not score any words on this test are awarded a baseline reading age of six years.

METHOD

Subjects

The subjects were children from a local Oxfordshire school. This time they were slightly advanced at reading for their age, as can be seen:

N	MEAN AGE	S.D.	READING AGE	S.D.	BPVS(IQ)	S.D.
22	6;3	3.45	6;8	3.10	109.3	14.2
14	6;0	4.39	6;0	0.00	109.4	14.4

i) Overall design

The children were tested under three different conditions - Beginning, End and Control (to be described) - with three different types of test words per condition - Target, C1 and C2. The test words were a mixture of analogous and non-analogous words, and will be described more fully later. A repeated measures design was used so that all the children did all the conditions and got all the words. Different subjects got different word sets on different conditions. The children were split into three groups matched for reading age and chronological age, and each group got the three conditions in different orders.

Therefore, there was full counterbalancing of words and conditions.

ii) Pretest

In order to ensure that all the words being used were new to the children, all the subjects were first tested on all the words being used in the experiment. Only children who were unable to read any of the words were included in the study.

iii) Procedure common to all trials

The experiment was introduced as a word game about working out words. On each trial the child was given a clue word "to help you work out other words". For example, if the clue word was ´beak´, the child was told "This is your clue word. This word says "beak". So this word says "beak"...."What does this word say?". The child was then given the test words to try and read in random order.

Three types of test word were used on each trial. These were Target words, which were analogous to the clue word; control words which shared three letters with the clue word but could not be worked out by analogy; and words which were analogous to one of the other clue words used in the experiment. Three words of each type were presented. In each case the child was told "This word says "beak"...What does this say?" The child´s pronounciations were recorded.

Each child was given two clue words per session, making two sets of nine test words to read in each case. There were six sets of words in all.

iv) The three conditions

The ability to make analogies was assessed under three different conditions. These were:

1. Beginning - the Target test words were analogous to the clue words at the beginning e.g. if the clue word was ´beak´ the Target words were bean, bead, beat.

2. End - the Target test words were analogous to the clue words at the end e.g. if the clue word was ´beak´, the Target words were peak, weak, speak.

3. Control - here Target and control words were presented as usual but without a clue word to help the child. The experimenter simply said "What does this say?" each time. Target words here were a combination of Beginning and End words e.g. the child could get bean, weak, beat or peak, bead, speak.

v) The three wordtypes

Three types of test words were given on each trial, consisting of three Target words and six control words. These

were:

1. Target words - words analogous to the clue words used on a given session, either at the beginning or the end depending on the condition.

2. Control Type One (C1) words - words matched in frequency to the Target words which also had three letters in common with the clue words but which could not be read by analogy. For example, if the clue word was 'beak' these were lake, bask, bank.

3. Control Type Two (C2) words - words which were Target and Control words for a clue word other than the one being used on a given session e.g. bean, peak and lake could be C2 words for the clue word 'rail'.

As will be apparent, the C2 manipulation meant that each test word was actually seen twice over the experiment as a whole, once in relation to the clue word from which analogies could be made and once as a control for another clue word. This was intended as a strong test of the analogy hypothesis, since it was expected that the children would only be able to read these words on the occasion on which analogy could be used.

vi) Additional measures of individual differences

Following the experiment, the children were given standardised tests of verbal I.Q., memory and coding ability as in experiment one. The tests used were the same, that is:

a) The British Picture Vocabulary Scales
b) The WISC digit span subtest
c) The WISC coding subtest

vii) Rationale

If children are able to make analogies in reading, they should be better at reading the Target words than the control words in the Beginning and End conditions only, as these are the only times analogies can be made. There should be no superiority of Target words over control words in the Control condition, however, as no clue word is present in this condition. So the pattern of results expected was that Target words should be read better than C1 and C2 words on the Beginning and End conditions, but not on the Control condition.

RESULTS

If children are able to make analogies in reading without any training on the relevant orthographic sequence, they should be better at reading the Target words than the Control words on the Beginning and End conditions only. This pattern of results seems to be supported. The mean number of words read correctly

by condition and wordtype is given below, separated for readers and non-readers:

Mean number of words read correctly, maximum = 6

GROUP	CONDITION	WORDTYPE TARGET	C1	C2
READERS	BEGINNING	1.95	1.14	1.05
	END	3.50	1.00	1.40
	CONTROL	1.32	1.00	0.77
NONREADERS	BEGINNING	0.62	0.38	0.08
	END	1.62	0.08	0.00
	CONTROL	0.08	0.31	0.08

As can be seen, the Target word score on the Beginning and End conditions is higher than the control word scores for both groups. This is not true of the Control condition.

To see whether these results were significant for the readers, a 3(Condition) x 3(Wordtype) analysis of variance was performed, taking the number of words read correctly as the dependent variable. The Anova showed a significant interaction between Condition and Wordtype ($F= 4.85$, $p<0.0015$).

Post-hoc tests (Neumann-Keuls) showed that the interaction was due to performance on the Target words being significantly different from performance on the control words for the Beginning and End conditions only, ($p< 0.05$). These results suggest that analogies are being made.

For the non-readers, whose scores were not parametrically distributed, a Friedman Two-way analysis of variance by ranks was performed. This showed that the difference between Target and control words was only significant on the End condition . Post-hoc testing with the Wilcoxon matched-pairs signed-ranks test showed that the Target word score was significantly greater than the control word scores, as expected ($T = 0$, $p<0.002$). Again, this suggests that analogies are being made.

Additional measures of individual differences

In order to see whether the ability to make analogies was connected with individual differences in verbal ability, memory or coding skills, a number of fixed-order multiple regressions were run taking the number of analogies made between the beginnings of words (AnlogB) and the ends of words (AnlogE) as the dependent variables. No significant relationships were found.

DISCUSSION

This result shows that very young children are able to make analogies between the spelling patterns in words. They are able to use words that they know to derive pronounciations for words that they cannot read in a flexible way. They do not have to be trained on the relevant orthographic sequence in order to do this, and the ability does not seem to depend on level of reading knowledge. Even children who do not yet score on standardised tests of reading can use an analogy strategy to decode words far above their levels of competence.

This result is an exciting one, since it suggests that the ability to make analogies is not a developmental ability at all. Instead, it seems to be a fundamental strategy in learning to read that is available very early on in a child's dealings with print. On reflection, this is not very surprising, since progress in reading is heavily dependent on the ability to classify words on an orthographic basis. It is only if a child can recognise that words like 'peak', 'weak', and 'speak' have a common element in the orthographic segment 'eak' that progress beyond learning each word as a unique visual whole becomes possible. Orthographic classification is also fundamental to the notion of regularity in orthography. It is only by recognising the orthographic similarity between words like 'beak', 'peak', and 'break' that 'break' can be understood to be an exception word - as its pronounciation differs from that predicted by its spelling pattern. The analogy mechanism underlies all these insights into how orthography works.

The finding that even non-readers can make analogies between the ends of words differs sharply from the conclusions arrived at by Marsh and Desberg (1983) on the basis of their work on young readers' use of analogy. They conclude that analogy is a developmentally sophisticated strategy characteristic of children already in the period of concrete operations. The results reported here present a very different picture of analogy, implying that it is a strategy used spontaneously very early on in reading, and not dependent on developmental level in any way. The discrepancy between these findings and the work of Marsh et al (1977, 1981) may arise because the studies of Marsh et al rely on the use of nonsense words. To examine this possibility further, a study is now being completed using children at three different stages of reading, and utilising both words and nonsense words. Results so far suggest that no big differences in results will be found.

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FULL LIST OF WORDS USED

EXPERIMENT ONE

TAUGHT PAIRS			TEST WORDS	
Consistent	Inconsistent	Control		
peak	peak	peak	A	beak
leak	steak	loan		weak
			B	break
			C	lion
				tour
good	good	good	A	hood
stood	food	seen		wood
			B	mood
			C	flee
				hair
own	own	own	A	sown
flown	clown	draft		mown
			B	town
			C	nook
				hang
rose	rose	rose	A	pose
nose	whose	shape		hose
			B	lose
			C	dent
				rage
boot	boot	boot	A	hoot
toot	soot	lied		root
			B	foot
			C	shear
				plain
seat	seat	seat	A	beat
neat	sweat	hook		meat
			B	great
			C	died
				teeth

EXPERIMENT TWO

CLUE	BEGINNINNG	END	CONTROL 1
beak	bean	peak	lake
	bead	weak	bask
	beat	speak	bank
hark	harp	lark	hawk
	harm	bark	hair
	hard	dark	hear
rail	rain	tail	real
	raid	hail	lain
	raise	sail	pairs
seen	seed	queen	nest
	seem	green	nose
	seek	keen	send
coat	coach	float	cast
	coast	boat	cost
	caol	goat	cart
skin	skip	chin	silk
	skim	pin	pink
	skill	win	sign